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PROGRAMME PLANNING

Country and intercountry programmes and projects

ASSISTANCE FOR A GLOBAL PROJECT

Reducing maize losses to insect pests by enhancing host plant resistance with bacillus thuringiensis toxin genes (GLO/91/014)

International Maize and Wheat Improvement Centre (CIMMYT)

Recommendation of the Administrator

Estimated UNDP contribution	$6,250,000
Duration	Five years
Executing agency	OPS

I. BACKGROUND

1. Maize is a staple cereal for people throughout the world and ranks third in importance after wheat and rice in annual production. Data on 29 major maize production countries of the developing world indicate that 55 per cent of the total area is seriously affected by insect pests. Field and storage pests typically cause losses of 20 per cent or more in developing country maize production. Lepidopteran insects are among the most important of these pests in the developing world. Globally chemical control of maize insect pests is estimated to cost more than $3 billion per year.

2. Synthetic chemical control of insects is increasingly viewed as a threat to human health and the environment. Concern about small-scale farmers using pesticides is especially serious given their generally poor knowledge of pesticide safety and their inability to afford appropriate safety devices, etc. Thus, there is a growing awareness of the potential hazards associated with the formulation, manufacture, transport, mixing, application, and disposal of synthetic chemical pest controls, and agreement on the need for alternative effective and economical control technologies.

3. Private companies in the developed world have invested millions to develop genetic engineering techniques for temperate maize improvement. These recent advances in biotechnology will expand the pool of genes available to temperate maize breeders. However, realizing the promise of this technology for tropical maize in developing countries implies a sizeable resource investment. Furthermore, a collaborative research involving both public and private sector entities is the most expeditious strategy to realize the development and application of biotechnology in tropical maize improvement.

4. Many developing countries are concerned about the growing disparity between North and South in the development of and access to modern molecular and cellular biology and genetics. The fact that much of the current technology is proprietary, especially in an important commercial crop such as maize, exacerbates their concern. By bringing the private sector into a collaborative research programme on tropical maize, this project will assist developing countries to gain access to advanced technology.

II. THE PROJECT

5. The UNDP contribution is part of a larger International Maize and Wheat Improvement Centre (CIMMYT) programme to transform tropical maize in order to increase sustainable production and significantly reduce the need for synthetic chemical pesticides on maize in the developing world. The project will use advanced technology from public and private sources to generate tropical maize germplasm that has enhanced and durable resistance to major insect pests of maize (primarily from Africa and Latin America) and eventually provide improved germplasm to breeders and farmers in developing countries. The strategy will be to strengthen the insect resistance genes already available from various maize sources by the addition of genes from the soil bacterium Bacillus thuringiensis (B.t.). These bacterial genes encode proteins toxic to specific maize lepidopteran species. Thus, the new technology now allows us to introduce promising insect resistance genes from B.t. into tropical maize. The procedure, known as transformation, incorporates the gene into the new host, enabling the latter to produce an entirely new plant constituent. To obtain this goal in a timely and cost-efficient manner, UNDP will support a coalition of public and private entities working with CIMMYT on specific technical aspects of the project. CIMMYT would enter into arrangements with individual collaborators based on research results, performance, new developments in biotechnology, and within the existing guidelines and regulations for the development, testing, and release of the products of genetic engineering.

6. Certain advanced laboratories in developing country programmes will assist CIMMYT and are undertaking research of direct relevance to the project. For instance, the National Maize and Sorghum Research Centre of the Brazilian Agricultural Research Enterprise has already located some strains of B.t., conducted biological control studies involving specific maize pests, and identified tropical maize genotypes with high embryogenic formation and regeneration capacity that will be useful in the transformation process. The Centre for Research and Advanced Studies of the Mexican National Polytechnic Institute has isolated several hundred B.t. strains from samples taken throughout Mexico and cloned genes of B.t., kurstaki and tenebrionis that encode crystal proteins toxic to various Lepidoptera and Coleoptera. These laboratories are participating in a Latin American biotechnology network through a regional programme supported by UNDP and are now performing joint research with CIMMYT on maize tissue culture and B.t. toxicity to maize pests. In addition, the Centre de Coopération Internationale en Recherche Agronomique pour le Développement in France will make a substantial scientific contribution to the research.

7. Large international companies have invested considerable resources and already achieved notable progress in temperate maize transformation. Their efforts have focused on transforming temperate maize to enhance its resistance to insect pests of North America and Europe. Based on a comprehensive analysis, it is clear that no substantial effort is being made in the private sector to transform tropical maize for developing country markets. Without a sustained multilaterally led coalition of research collaborators, it is unlikely that the transformed tropical maize or the underlying technology will soon reach developing countries. To determine the possibility of gaining access to this technology, CIMMYT has approached several European and North American companies that reported successful transformation of temperate maize. The Centre has opportunities for agreements whereby CIMMYT would obtain advanced technology for screening, manipulating, and transferring B.t. genes into tropical maize and at a fraction of the cost of the Centre developing this technology on its own or through other public sector institutions.

8. CIMMYT agreements with public and private sector institutes will be based on performance and development of specific products. In some cases, CIMMYT may ask different collaborators to develop the same product. This strategy would promote competition between providers of key products and ensure the quality and punctual delivery of those components.

9. The following objectives will be pursued:

(a) Identification of at least three Bacillus thuringiensis strains that harbour endotoxin genes with effective insecticide action against the major lepidopteran insect pests of tropical maize;

(b) Identification, characterization and isolation of the genes encoding specific B.t. crystal proteins with high levels of toxicity for maize insect pests;

(c) Preparation of gene constructs that allow the expression of crystal protein genes in transgenic maize plants;

(d) Development of appropriate tissue culture technology for regeneration of tropical maize;

(e) Introduction and expression of the B.t. genes in tropical maize plants.

10. It is expected that by the end of the project, CIMMYT will have fertile maize plants that contain genes encoding the endotoxin of Bacillus thuringiensis which express sufficient levels of this protein to confer significant resistance to the major lepidopteran insect pests of tropical maize. It is also expected that these plants will be of advanced genotypes and will thus already possess some resistance to multiple tropical borer species. Thus, they will be of interest to maize breeding programmes of developing countries and private seed companies. It is expected that this maize will allow developing country farmers to obtain increased and stable yields with less need for synthetic chemical pesticides.

11. Questions on (a) biosafety during the research and development on maize transformation; (b) subsequent release of transformed maize and its potential impact on the environment; (c) legal restrictions on the marketing of the transformed maize and free access of the CIMMYT transformed maize germplasm to all countries, have been considered. All research and development will be done under relevant national regulatory legislation or in its absence with government approval and under regulations in force in developing countries. Secondly, no transformed maize will be released for distribution or field testing until all relevant environmental impact criteria are fully satisfied and specifically approved by the Governments concerned. If a country does not have relevant environmental impact criteria, government approval will be requested on the basis of other generally accepted criteria from developed countries. Lastly, CIMMYT policy stipulates that all genetic material is available to any interested Government or responsible private party.

12. The UNDP contribution will be executed through the Office of Project Services with overall direction from the Division for Global and Interregional Projects (DGIP), and implemented by CIMMYT in conjunction with a number of public and private entities. A programme oversight committee will be appointed that will include UNDP and invited outside consultants from developing and developed countries and the Food and Agriculture Organization of the United Nations (FAO) (experts on biotechnology, environmental regulations, research and development management). The committee will be appointed by CIMMYT in consultation with the Administrator of UNDP. The group will meet annually to review and approve the research plans for the following year. The oversight committee will review and provide recommendations on all research sub-contracts.

13. The proposal has several features that recommend it for a global project. At least two advanced laboratories in developing countries will collaborate with CIMMYT and the private sector companies in North America and Europe in an effort to bring the most advanced technology available to tropical maize improvement. In addition, the Centre de Coopération Internationale en Recherche Agronomique pour le Développement will make a research contribution to the project. The project will produce tropical maize germplasm that will resist attack from several very serious insect pests that inflict heavy yield losses in Africa, Asia and Latin America. Thus, the proposal emphasizes three major themes that were identified by the Governing Council in its decision 90/34 which are: technical cooperation among developing countries; transfer and adoption of technology for development, and natural resource management for sustainable development. The genetic materials, methodologies and supporting systems developed through the project will directly benefit maize research throughout the tropical world as they produce new pest-resistant tropical maize varieties. The ultimate beneficiaries of this project will be the general public in maize-producing countries, who should experience a reduction in the levels of synthetic pesticides in the environment, and have at their disposal less expensive and larger supplies of maize.

14. The project will be subject to periodic external reviews and will receive a thorough evaluation at termination. Furthermore, opportunities will be sought to collaborate with other donors, countries and institutions that may wish to associate themselves with this research.

15. Of the total budget of $6,250,000, at least 53 per cent will be used to support collaborative efforts with public institutions in Mexico, Brazil and France and with private biotechnology companies. Private sector companies with proprietary knowledge and a possible interest in collaborating with CIMMYT may include companies in Europe and North America.

III. RECOMMENDATION OF THE ADMINISTRATOR

16. The Administrator recommends that the Governing Council approve this project.